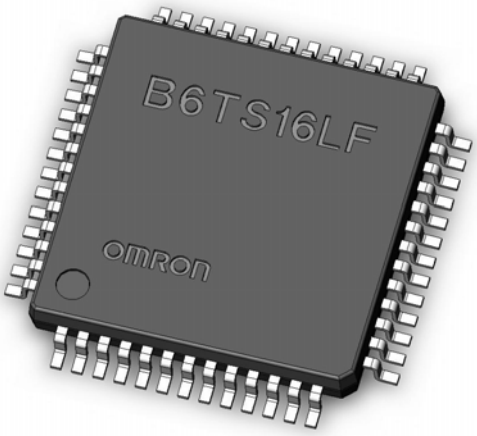
TYPE: B6TS-16LF

TOUCH-SENSING IC

USER MANUAL



Introduction

Thank you very much for purchasing the touch sensor.
The touch sensor is a product that has been developed based on our advanced technology and rich experience.
This user manual describes the information necessary for use of the sensor, such as its functions, capabilities and proper usage.

When using the touch sensor, please keep the following in mind:
- Only specialists with knowledge of electricity must handle the touch sensor.
- Please read and understand the contents of this manual thoroughly to use the touch sensor appropriately.
- Keep this manual handy to refer to at any time you need it.

Points to note when using the touch sensor

- Although OMRON makes constant efforts to improve the quality and reliability of its semiconductor products, products such as this touch sensor may malfunction or break.
  Before using the touch sensor, please contact OMRON's business development personnel, if necessary, to confirm product specifications, while also paying attention to using the sensor with a sufficient margin allowed for its ratings and capabilities, and taking safety measures such as installing safety circuits to minimize hazards in the unlikely event that a failure of the sensor might occur.
- Basically, this product is not designed and manufactured for use in equipment or systems operated under potentially hazardous conditions. If you intend to use the touch sensor with any of the following systems, facilities or equipment, be sure to consult OMRON sales personnel or an agent or dealership first:
  (A) Atomic power control equipment, incineration facilities, railroads, aircraft, vehicle equipment, medical appliances, amusement machines, safety devices, and facilities that must comply with the regulations of administrative agencies and their respective industries.
  (B) Systems, machines and devices that are potentially hazardous to humans and property.
  (C) Other usages that require a high degree of safety.

The technical information contained in this manual is prepared only to describe typical performances and application examples of the product. Application of the products based on the information does not infer the grant of any OMRON or third party intellectual property, right or license.

1. Preventing malfunction caused by contact with an electric conductor other than a human finger with the touch electrode
   Because this product measures the electrostatic capacitance of the detector (electrode), the product may operate if something other than a human finger is brought into contact with the electrode. Therefore, a fail-safe design is required for use of the product so that it does not cause any functional or safety problem even on such occasions.
   Substances, etc., that may cause a malfunction if they are present near to or on the detector are:
   - Water, metal, animals, other conductive materials

2. Preventing operational error
   Because this product detects human touch, it may operate if the detector (electrode) is touched only lightly or if somebody remains nearby. When incorporating this product into a device, check the detection range thoroughly, and employ measures to prevent the device from malfunctioning caused by operational error.
   Especially, if the device is used where children may come into contact with it, provide some safety measure such as a child safety lock.

3. Preventing the entry of water or corrosive gases
   If water or a corrosive gas enters the operating part of the sensor (electrode), in the event of a short circuit or corrosion of the electrode, the sensor may malfunction or its detection sensitivity may be lowered. If the product is supposed to be used in an environment where this may occur, employ some structure to prevent the entry of water or gas, and check to be sure in actual operation that the device is protected securely against such an event.

4. Preventing malfunction caused by noise
   The product may malfunction if subjected to excessive noise.
   Check to be sure that no safety problems are caused by excessive noise.

5. Preventing direct touching of the electrode
   Do not employ any structure that exposes the surface of the touch electrode to the air and allows somebody to touch the metal part of the touch electrode directly. Otherwise, the safety of the product may be impaired, accumulated electrostatic charges may damage the product, or the electrode may corrode. Adopt a structure that covers the surface of the touch electrode with nonconductive material and does not allow anybody to touch the metal part of the electrode directly.
   The recommended thickness for the nonconductive material is:
   Resin material (dielectric constant of 2 to 3): no more than 2mm
   Glass material (dielectric constant of about 5): no more than 4mm

6. Configurable data
When setting data with commands, consider the environment and conditions for using the touch sensor (e.g., location and circuit configuration) to determine proper values which may not cause functional or safety problems.

Proper usage

1. Method of transportation and storage

(1) Do not drop or apply any shock to the touch sensor because it is a precision device.
If the sensor is thrown or dropped, it may break.

(2) When carrying or storing the touch sensor, keep its packaging properly oriented.
If the packaging is placed upside down or tilted, the sensor may be subjected to some undue force and may break.

(3) Store the touch sensor under the following conditions to prevent the package from absorbing moisture:
Otherwise, the sensor may break when the package is mounted.
<Storage conditions>
A. Before opening the moisture-proof pack (aluminum laminate pack):
[Temperature, humidity] -65 - 150°C, -80% or less RH
[Term of validity] One year
When the sensor is used after a long period of storage, make sure that no damage, dirt, or rust is present on the pack.
B. After opening the moisture-proof pack (aluminum laminate pack):
Until the package is mounted, the following conditions are recommended for storage of the package:
(In accordance with MSL3/JEDEC-STD-020)
[Temperature, humidity] 30°C 60% RH
[Term of validity] 168 hours
C. Temporary storage after opening the moisture-proof pack:
After opening the moisture-proof pack, it is recommended to store any parts remaining in the same package after mounting due to your manufacturing quantity reason in a desicator (device to keep temperature constant and humidity as low as 20% or less RH), or return them into the moisture-proof pack then seal the pack immediately after using them.
Do not use or store the touch sensor where it will be subject to corrosive gases such as hydro sulfuric gas or salt air, or exposed to oil or direct sunlight.

(4) Do not use or store the touch sensor where it will be subject to corrosive gases such as hydro sulfuric gas or salt air, or exposed to oil or direct sunlight.

(5) Where either of the following conditions [1] or [2] is applicable, baking the sensor package in the following manner is recommended in order to remove moisture:
The tray used in the moisture-proof pack can be stored in a high-temperature chamber because it is heat-resistant. However, place the tray on a flat base such as a level block, and then cool it down on the base to prevent deformation after baking.
[1] The above storage conditions A-C are exceeded.
[2] The color of the 30% RH detection part of the indicator changes to lavender or pink.

<Baking method>
[Temperature] 125°C
[Time] 6 hours
[Number of times] Up to three (Cumulative time limit: 72 hours)

2. Measures against electrostatic charges during handling

Keep the relevant electric equipment, work-bench and worker at the same potential.
Lay a conductive mat with a surface resistance of 10 kΩ- 10 MΩ on the work-bench, and ground the mat.
The user must make sure that there is no electric leakage from the electric equipment to ground. The electric leakage must be limited by the use of a resistor of about 1 MΩ for safety. All safety regulations must be observed.
Any electric leakage from the electric equipment is undesirable from the viewpoint of worker safety.
Check to be sure that there is no electric leakage from the tester, curve tracer, oscilloscope, or the like, and then ground the equipment. Any electric leakage can break the CMOS IC.
The same precautions apply to soldering irons.

3. Recommended soldering Conditions

Recommended soldering conditions (Pb free)
Temperature conditions for mounting the IC chip
When mounting the IC chip at a high temperature by using reflow soldering, the melting temperature of the solder depends on the mounting board and paste adhesive materials of the mounting board and the paste adhesive. Referring to the mounting temperature profile shown in the following figure, choose the optimum soldering temperature within the profile.

(1) Reflow method (infrared light reflow and air reflow)

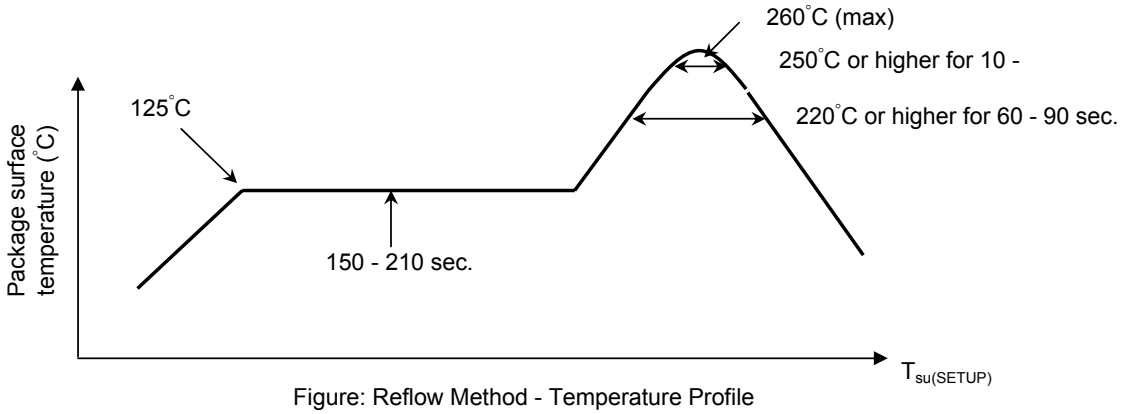


Figure: Reflow Method - Temperature Profile

(2) Wave soldering method (called known as flow soldering or dip soldering)
Wave soldering method using Pb-free solder is not recommended.

(3) Soldering iron (manual soldering)
Solder using a soldering iron for semiconductor devices under the following conditions:
[Iron tip temperature] 350 ± 5°C
[Soldering time] No longer than 5 sec/pin

4. Recommended wash conditions

The wash conditions compliant to MIL-STD-883C are recommended.
When using rosin flux wash, check the following items:
(1) Amount of contamination containing residual ions (or no ions)
(2) Administrative directions and regulations
(3) Melting resistance of parts

5. Handling after mounting parts on PCB

When dividing a PCB on which ICs are mounted, do not apply any excessive force to the ICs. Otherwise, the internal IC chips may be broken.

6. Applied voltages and currents

(1) Do not apply to any pin any voltage or current that exceeds the absolute maximum ratings.

(2) Use the device within the recommended specifications to enhance the quality of the device.

(3) Do not apply any forward bias to any of the pins.
Otherwise, excessive forward current may cause thermal breakdown of the IC.

(4) Do not connect any output pin directly to power. If any output pin is directly connected to low-impedance power, the internal wiring may melt down or break thermally due to excessive current.

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2. Pin connections
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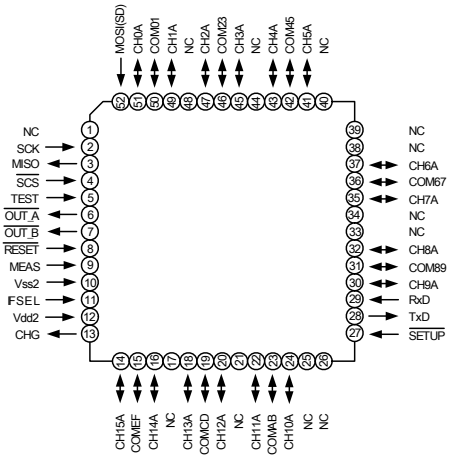
1. Overview

This chip is a touch-sensing IC to detect micro capacitances and can be used in touch sensors.
Internally, the chip employs the CMOS process and is contained in a 52-pin TQFP plastic package.
The IC has 16 independent measurement pins, of which each can measure capacitance independently.
On/Off (only 2CH) and serial communication output can be selected as the output mode.
The IC is provided with an EEPROM that can store operation mode and other parameters.

2. Pin connections

2.1 Pin arrangement diagram



Note: TEST terminal (5pin) is used for testing during manufacture of the IC.
During normal operation of the IC, connect it to Vdd through a pull-up resistor.

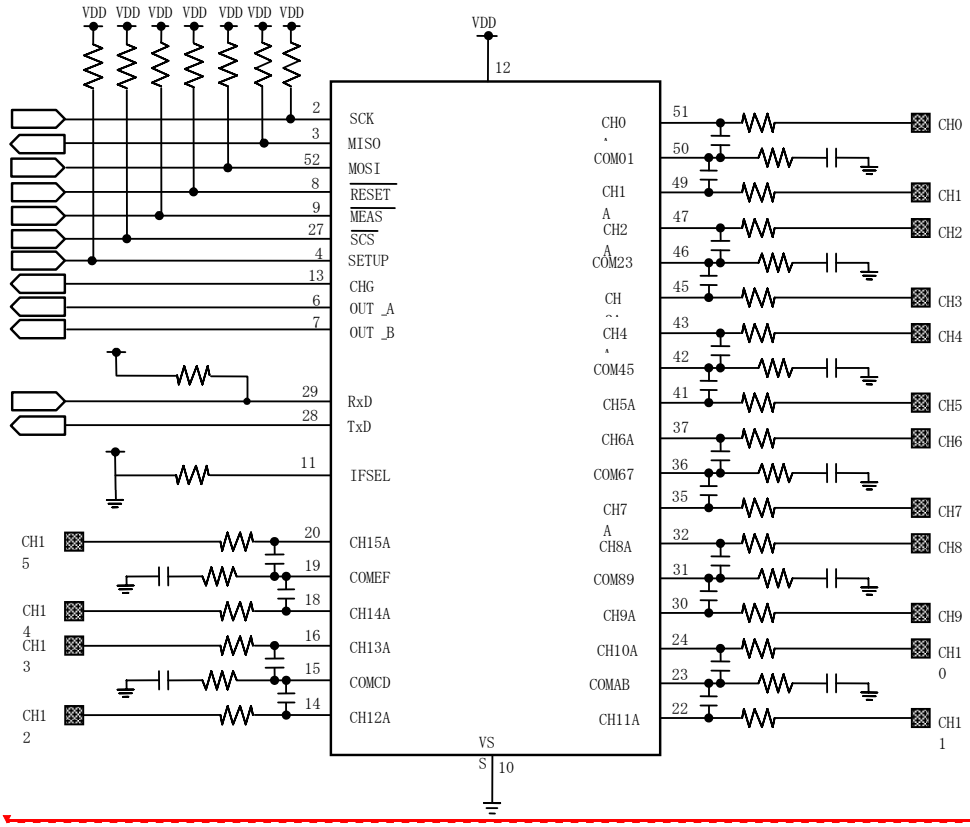
2.2 Pin functions

Pin No.	Designation	Input/ Output	Function
51 49 47 45 43 41 37 35 32 30 24 22 20 18 16 14	CH0A CH1A CH2A CH3A CH4A CH5A CH6A CH7A CH8A CH9A CH10A CH11A CH12A CH13A CH14A CH15A	I/O	Measurement pins (channels 15 - 0) Connect these pins to the touch electrode through resistors.
50 46 42 36 31 23 19 15	COM01 COM23 COM45 COM67 COM89 COMAB COMCD COMEF	I/O	Common-use measurement pins (channels 15 - 0) Common-use measurement pins for two channels each Connect these pins to charge capacitors through resistors.

Pin No.	Designation	Input/ Output	Function
12	V_{dd}	I	Power Supply Input (3.0 - 5.5V)
10	Vss	I	Ground
11	IFSEL	I	Select pin for SPI interface mode Pull-up is for 4-wire SPI / Pull-down is for 3-wire SPI
6	$\overline{\text{OUT_A}}$	O	Any channel can be specified for this output pin (logic switching is available).
7	$\overline{\text{OUT_B}}$	O	Any channel can be specified for this output pin (logic switching is available).
13	CHG	O	An output pin which indicates the operation status. [Normal measurement mode] Outputs measurement results. [Serial communication mode] Measurement termination output Two output modes are available: 1. High-signal output every time a measurement finishes. 2. High-signal output when the condition changes in any one of the channels (touch→no touch, no touch→touch). [Setup mode] When setup mode is entered, CHG pin goes high. However, when EEPROM write command is received and data is being written in EEPROM, CHG pin remains low.
52	MOSI (SD)	I (I/O)	In using 4-wire SPI : Serial communication data input (In using 3-wire SPI : Serial communication data I/O)
3	MISO	O	In using 4-wire SPI : Serial communication data output
2	SCK	I	Serial communication clock input
4	$\overline{\text{SCS}}$	I	Serial communication mode chip select input
27	$\overline{\text{SETUP}}$	I	Setup mode. Low input to this pin moves the chip into setup mode. (To suppress noise, connect to Vss via a bypass capacitor of 0.01 μF in addition to resistor.)
28	TxD	O	UART serial communication data output
29	RxD	I	UART serial communication data input
9	MEAS	I	Initiation of measurement. Capacitance measurement is initiated by inputting high to this pin. While low is input to this pin, the chip is held in standby status.
5	TEST	I	(Connect to Vdd through a pull-up resistor)
8	$\overline{\text{RESET}}$	I	Reset signal input. Inputting low to this pin resets the chip. Built-in power-on reset can work with around 5kΩ pull-up resistor (no need external reset circuit)

2.3 Example of circuit

Note 1: Connect Rr, Cr, Rc, and Cc to each touch electrode, as shown in the diagram below.
Refer to the design tool (B6Tworkbench – Circuit Constants) for recommended values.
* Reference values: Rr=10kΩ, Cr=22pF, Rc=4.7kΩ, Cc=0.1μF



Note 2: Connect a bypass capacitor of about 0.1 μF between Vdd and Vss using wires as short as possible.
Note 3: Connect a bypass capacitor of about 0.01 μF between /SETUP pin and Vss.
Note 4: When UART is not used, connecting RxD pin (29pin) to VDD through a pull-up resistor as possible as near from this IC.
Note 5: When 3-wire SPI is used (pull-down at IFSEL), MOSI pin operates as SD(I/O) and MISO has no function (floating – not connected).
Note 6: IFSEL terminal (11pin) is for selecting pin for SPI interface mode.
Pull-up is for 4-wire SPI / pull-down is for 3-wire SPI.

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3. Operation mode

This chip has three operating modes. Each mode is selected by the MEAS pin and /SETUP pin.

(1) Normal measurement mode ---------- Normal operation mode to detect touch/no-touch.
Serial communication and On/Off output mode can be used.

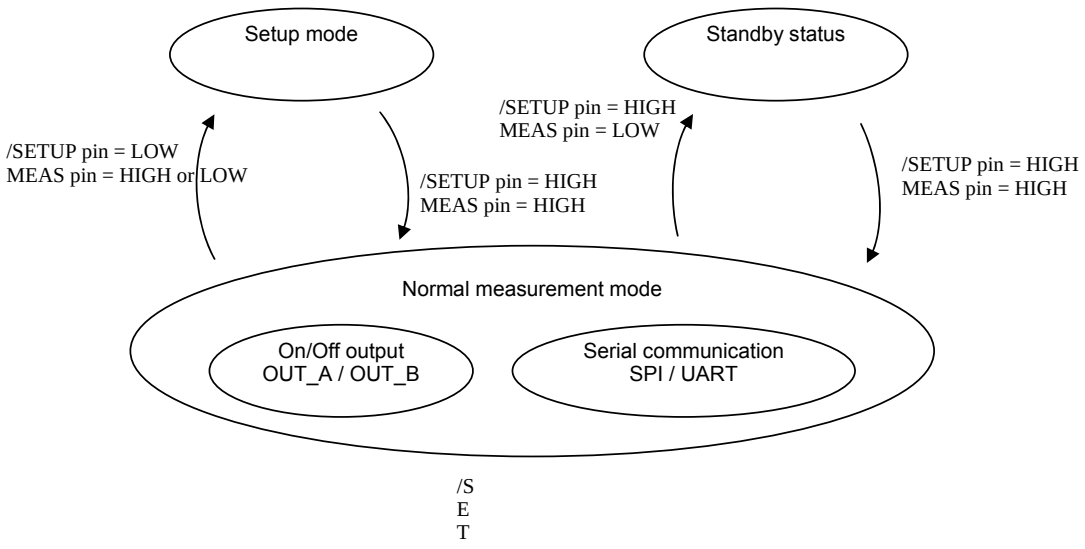
(1-1) On/off output mode ---------- OUT_A and OUT_B pins are used. (Only 2ch can be used)
Touch/no-touch detection results are output from the respective channels with low/high signal.
* Output logic can be set with BPOL command.

(1-2) Serial communication output ---------- Measured results are transmitted in serial below.
1. 4-wire SPI using SCK, /SCS, MOSI, MISO signals.
2. 3-wire SPI using SCK, /SCS, SD signals.
3. UART using RxD, TxD signals.

(2) Setup mode ---------- Chip operation is set to serial communication.

(3) Standby mode ---------- Mode to non-measurement.
This can be used for measurement synchronous among multiple B6TS

/SETUP pin	MEAS pin	Operation mode
HIGH	HIGH	Normal measurement mode
HIGH	LOW	Standby - without executing measurements
LOW	HIGH or LOW	Setup mode

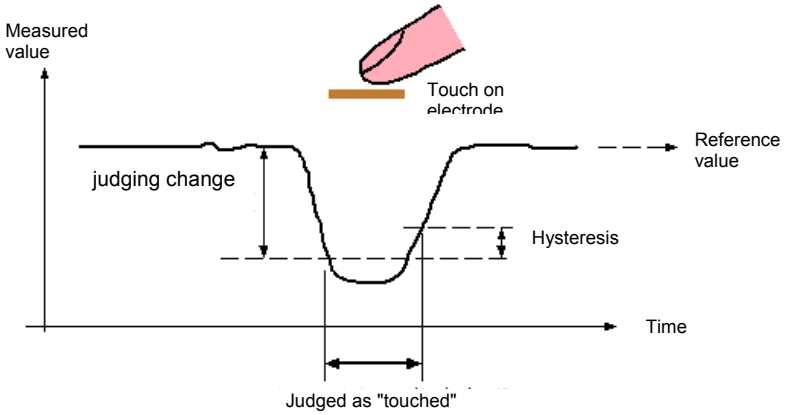


4. Measurement

The chip measures the discharge of the charge stored in the charge capacitor. When a finger is placed close to the touch electrode, the electrostatic capacitance of the electrode increases and the discharge time for the charge becomes shorter. The chip has a built-in counter to measure the discharge period. Whether the sensor has been touched or not is judged according to whether the length of the discharge period exceeds a specified value or not. Hereafter, the length of the discharge period is referred to as the measured value.

The measured value when the sensor is not touched is called the reference value. The change of the measured value which allows a judgment that the sensor is touched is called judging change and the change of the measured value when returning from on status is called hysteresis. These 3 parameters define the switching characteristics of each touch channel and can be set for each channel independently.
The relationships between the measured value and the above values are as follows:

[Measured value] < [Reference value]-[judging change] → Touch
[Measured value] > [Reference value]-[Judging change]+Hysteresis → Touch to no touch



Even in the no-touched state, the measured value changes according to variation in the environment (output drift). The chip is provided with an automatic drift compensation function, which can cancel mild changes of the measured value due to variation in the environment. The drift compensation function can be enabled or disabled in setup mode.

5. Serial communication

It is possible to read out measured values and set the operation mode by sending/receiving data to/from this chip through serial communication.

Serial communication is performed with the three-wire SPI or UART using SCS (chip select), SCK (transfer clock), and SD (data transmission and reception: host -> B6TS, B6TS -> host).

* Be sure to use only SPI or UART with your design.
  If you use both of SPI and UART, communication errors may occur due to out of synchronization.

5.1 SPI communication

The SPI communication method works as follows:
(Refer to “8. Electrical specifications” for specific communication timing, etc.)

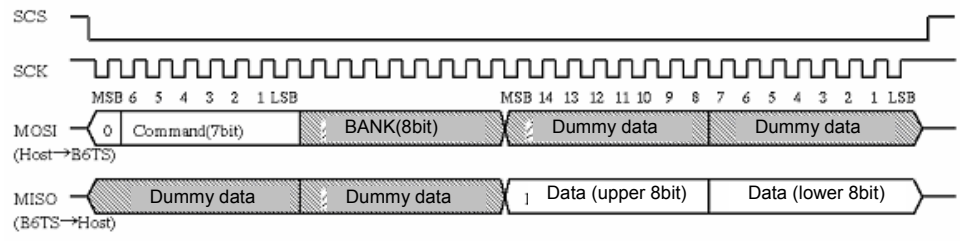
- Operation in SPI slave mode
  Supply SCS (chip select) and SCK (transfer clock) from an external source.
- SCK (transfer clock) is set to high during idling. The data is latched at the rising edge of the clock.
- The data (SD) is in MSB first format.

This chip sends/receives data using 4 bytes, consisting of a command byte, dummy bytes, and 2 data bytes.

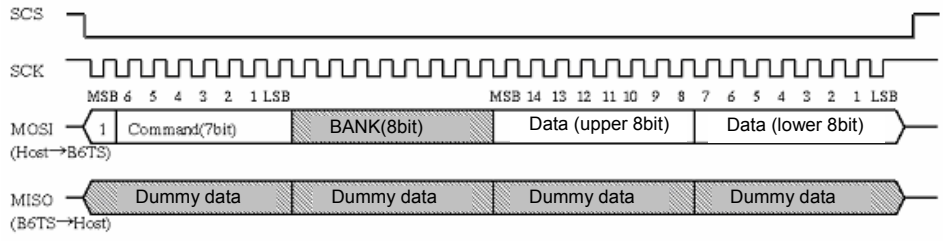
Command: 1 byte (MSB 1 bit is used for the read/write flag.)
Bank data: 1 byte (0x00 or 0x80 is set when accessing to commands 0x00 - 0x7F or 0x80 - 0xFF respectively.)
Data: 2 bytes

5.1.1 4-wire SPI outline

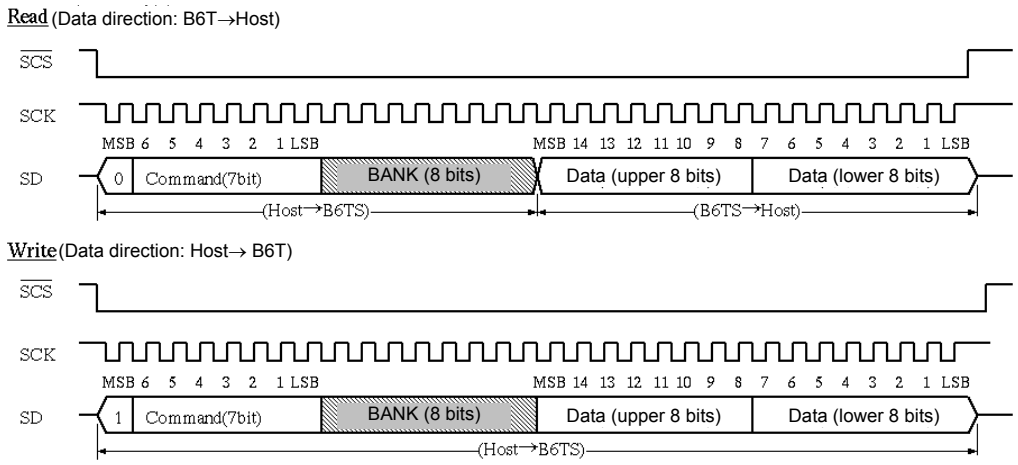
Read (Data direction: B6T→Host)



Write (Data direction: Host→B6T)



5.1.2 3-wire SPI outline



If data communication is performed during normal measurement mode, the measurement operation stops while the data is communicated.
Measurement will restart after communication completes (when measurement has been interrupted, values from the last measurement are read).

* If SCS is disabled while data is being transmitted or received, data transmitted or received by B6T up to that moment is lost.
* I/O of the SD pin toggles according to the data direction. Be sure to change the host pin I/O according to the SD pin direction.

5.2 UART communication

The UART communication method works as follows:

Bit rate	:	38400 bps
Data length	:	8 bits
Parity	:	None
Number of stop bits	:	1

5.3 Command access

- Access to commands 0x00 - 0x7F. (BANK data=**0x00**, refer to 5.1 SPI communication)
  - For read operation: Command Code. + 0x00 (BANK)
  - For write operation: Command Code. | 0x80+ 0x00 (BANK) + data (upper 8 bits) + data (lower 8 bits)
- Access to commands 0x80 - 0xFF. (BANK data=**0x80**, refer to 5.1 SPI communication)
  - For read operation: Command Code. & 0x7F + 0x80 (BANK)
  - For write operation: Command Code. & 0x7F| 0x80+ 0x80 (BANK) + data (upper 8 bits) + data (lower 8 bits)

* In accessing to commands 0x80 - 0xFF, be sure to excute AND operation with Command code & 0x7F.
* For write accesses, transmit each command ORed with 0x80.

6. Commands

The commands and data used in serial communication are listed below:
The data comprises read only data (read) and read/write data (read/write). If a write command is applied to read only data, the operation will be invalid.
Some data is not accessible in some operation modes. If inaccessible data is read out, the read data is indefinite. If inaccessible data is written, the data is ignored.

Command code (Designation)	*Main function*	*Read/write restriction*	*Access limit*	
			Normal measurement mode (in serial communication mode)	Setup mode
0x00(ID) - 0x31(CHYS11) 0x82(DCH12) - 0x85(DCH15) 0x8E(CREF12) - 0x99(CHYS15)	Measured data	Read only	Accessible	Accessible
0x39(CHEN) - 0x7B(ACDN11) 0xBB(OUTSEL) 0xC0(REF12) - 0xD3(ACDN15)	Parameter setting	Read/write	Inaccessible	

When writable data are written in this chip, the built-in register corresponding to each command is rewritten. Then, if the normal measurement mode is entered, the chip can be operated with the written parameters (mode, etc.). In this case, because only the built-in register is rewritten, the value in each register returns to its original value (value stored in EEPROM) when power is turned off and on again.

To store the built-in register value in EEPROM, an EEPROM write command (0x3F) must be received. When an EEPROM write command is received, the content of the register is stored in EEPROM.

* In actual writing procedure, transmit the command 0xBF(=0x80+0x3F) + 0x00 + 0x53 + 0x54
after transition to SETUP mode.

6.1 List of commands

BANK0: (Bank data=0x00)

Command code	*Desig-nation*	*Description*	*Access limit*			*Note*
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x00	ID	Chip ID	R	○	○	0x0101 for this chip.
0x01	BDATA	Detected result of each channel	R	○	○	1 channel 1 bit
0x02	DCH0	Ch0 measured value	R	○	○	
0x03	DCH1	Ch1 measured value	R	○	○	
0x04	DCH2	Ch2 measured value	R	○	○	
0x05	DCH3	Ch3 measured value	R	○	○	
0x06	DCH4	Ch4 measured value	R	○	○	
0x07	DCH5	Ch5 measured value	R	○	○	
0x08	DCH6	Ch6 measured value	R	○	○	
0x09	DCH7	Ch7 measured value	R	○	○	
0x0A	DCH8	Ch8 measured value	R	○	○	
0x1B	DCH9	Ch9 measured value	R	○	○	
0x1C	DCH10	Ch10 measured value	R	○	○	
0x0D	DCH11	Ch11 measured value	R	○	○	
0x0E	CREF0	Current Ch0 reference value	R	○	○	Result of drift compensation is reflected.
0x0F	CTHR0	Current Ch0 judging change	R	○	○	Result of drift compensation is reflected.
0x10	CHYS0	Current Ch0 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x11	CREF1	Current Ch1 reference value	R	○	○	Result of drift compensation is reflected.
0x12	CTHR1	Current Ch1 judging change	R	○	○	Result of drift compensation is reflected.
0x13	CHYS1	Current Ch1 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x14	CREF2	Current Ch2 reference value	R	○	○	Result of drift compensation is reflected.
0x15	CTHR2	Current Ch2 judging change	R	○	○	Result of drift compensation is reflected.
0x16	CHYS2	Current Ch2 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x17	CREF3	Current Ch3 reference value	R	○	○	Result of drift compensation is reflected.
0x18	CTHR3	Current Ch3 judging change	R	○	○	Result of drift compensation is reflected.

Command code	Desig-nation	Description	Access limit			Note
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x19	CHYS3	Current Ch3 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x1A	CREF4	Current Ch4 reference value	R	○	○	Result of drift compensation is reflected.
0x1B	CTHR4	Current Ch4 judging change	R	○	○	Result of drift compensation is reflected.
0x1C	CHYS4	Current Ch4 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x1D	CREF5	Current Ch5 reference value	R	○	○	Result of drift compensation is reflected.
0x1E	CTHR5	Current Ch5 judging change	R	○	○	Result of drift compensation is reflected.
0x1F	CHYS5	Current Ch5 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x20	CREF6	Current Ch6 reference value	R	○	○	Result of drift compensation is reflected.
0x21	CTHR6	Current Ch6 judging change	R	○	○	Result of drift compensation is reflected.
0x22	CHYS6	Current Ch6 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x23	CREF7	Current Ch7 reference value	R	○	○	Result of drift compensation is reflected.
0x24	CTHR7	Current Ch7 judging change	R	○	○	Result of drift compensation is reflected.
0x25	CHYS7	Current Ch7 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x26	CREF8	Current Ch8 reference value	R	○	○	Result of drift compensation is reflected.
0x27	CTHR8	Current Ch8 judging change	R	○	○	Result of drift compensation is reflected.
0x28	CHYS8	Current Ch8 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x29	CREF9	Current Ch9 reference value	R	○	○	Result of drift compensation is reflected.
0x2A	CTHR9	Current Ch9 judging change	R	○	○	Result of drift compensation is reflected.
0x2B	CHYS9	Current Ch9 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x2C	CREF10	Current Ch10 reference value	R	○	○	Result of drift compensation is reflected.
0x2D	CTHR10	Current Ch10 judging change	R	○	○	Result of drift compensation is reflected.
0x2E	CHYS10	Current Ch10 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x2F	CREF11	Current Ch11 reference value	R	○	○	Result of drift compensation is reflected.

Command code	Desig-nation	Description	Access limit			Note
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x30	CTHR11	Current Ch11 judging change	R	○	○	Result of drift compensation is reflected.
0x31	CHYS11	Current Ch11 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x32 : 0x35	(System reservation)					
0x36	MSA	Maximum sequential ON input.	R/W		○	
0x37	DCI	Drift compensation interval	R/W		○	
0x38	BPOL	On/off output polarity select	R/W		○	
0x39	CHEN	Channel measurement enable	R/W		○	
0x3A	(System reservation)					
0x3B	TOG	Toggle action	R/W		○	
0x3C	ACD	judging count	R/W		○	Lower 8bit : cumulative count in ON Upper 8bit : cumulative count in OFF
0x3D	SLP	Sleep time	R/W		○	
0x3E	MODE	Operation mode	R/W		○	
0x3F	ROMSTR	EEPROM write	R/W		○	Writing into ROM with dummy write
0x40	REF0	Ch0 reference value	R/W		○	
0x41	THR0	Ch0 judging change	R/W		○	
0x42	HYS0	Ch0 hysteresis	R/W		○	
0x43	RTHR0	Ch0 On-judgment ratio	R/W		○	
0x44	RHYS0	Ch0 hysteresis ratio	R/W		○	
0x45	REF1	Ch1 reference value	R/W		○	
0x46	THR1	Ch1 judging change	R/W		○	
0x47	HYS1	Ch1 hysteresis	R/W		○	
0x48	RTHR1	Ch1 On-judgment ratio	R/W		○	
0x49	RHYS1	Ch1 hysteresis ratio	R/W		○	
0x4A	REF2	Ch2 reference value	R/W		○	
0x4B	THR2	Ch2 judging change	R/W		○	
0x4C	HYS2	Ch2 hysteresis	R/W		○	
0x4D	RTHR2	Ch2 On-judgment ratio	R/W		○	
0x4E	RHYS2	Ch2 hysteresis ratio	R/W		○	
0x4F	REF3	Ch3 reference value	R/W		○	

Command code	Desig-nation	Description	Access limit			Note
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x50	THR3	Ch3 judging change	R/W		○	
0x51	HYS3	Ch3 hysteresis	R/W		○	
0x52	RTHR3	Ch3 On-judgment ratio	R/W		○	
0x53	RHYS3	Ch3 hysteresis ratio	R/W		○	
0x54	REF4	Ch4 reference value	R/W		○	
0x55	THR4	Ch4 judging change	R/W		○	
0x56	HYS4	Ch4 hysteresis	R/W		○	
0x57	RTHR4	Ch4 On-judgment ratio	R/W		○	
0x58	RHYS4	Ch4 hysteresis ratio	R/W		○	
0x59	REF5	Ch5 reference value	R/W		○	
0x5A	THR5	Ch5 judging change	R/W		○	
0x5B	HYS5	Ch5 hysteresis	R/W		○	
0x5C	RTHR5	Ch5 On-judgment ratio	R/W		○	
0x5D	RHYS5	Ch5 hysteresis ratio	R/W		○	
0x5E	REF6	Ch6 reference value	R/W		○	
0x5F	THR6	Ch6 judging change	R/W		○	
0x60	HYS6	Ch6 hysteresis	R/W		○	
0x61	RTHR6	Ch6 On-judgment ratio	R/W		○	
0x62	RHYS6	Ch6 hysteresis ratio	R/W		○	
0x63	REF7	Ch7 reference value	R/W		○	
0x64	THR7	Ch7 judging change	R/W		○	
0x65	HYS7	Ch7 hysteresis	R/W		○	
0x66	RTHR7	Ch7 On-judgment ratio	R/W		○	
0x67	RHYS7	Ch7 hysteresis ratio	R/W		○	
0x68	REF8	Ch8 reference value	R/W		○	
0x69	THR8	Ch8 judging change	R/W		○	
0x6A	HYS8	Ch8 hysteresis	R/W		○	
0x6B	RTHR8	Ch8 On-judgment ratio	R/W		○	
0x6C	RHYS0	Ch8 hysteresis ratio	R/W		○	
0x6D	REF9	Ch9 reference value	R/W		○	
0x6E	THR9	Ch9 judging change	R/W		○	
0x6F	HYS9	Ch9 hysteresis	R/W		○	
0x70	RTHR9	Ch9 On-judgment ratio	R/W		○	

Command code	Desig-nation	Description	Access limit			Note
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x71	RHYS9	Ch9 hysteresis ratio	R/W		○	
0x72	REF10	Ch10 reference value	R/W		○	
0x73	THR10	Ch10 judging change	R/W		○	
0x74	HYS10	Ch10 hysteresis	R/W		○	
0x75	RTHR10	Ch10 On-judgment ratio	R/W		○	
0x76	RHYS10	Ch10 hysteresis ratio	R/W		○	
0x77	REF11	Ch11 reference value	R/W		○	
0x78	THR11	Ch11 judging change	R/W		○	
0x79	HYS11	Ch11 hysteresis	R/W		○	
0x7A	RTHR11	Ch11 On-judgment ratio	R/W		○	
0x7B	RHYS11	Ch11 hysteresis ratio	R/W		○	
0x7C : 0x7F	(System reservation)					

BANK1: (Bank data=0x80)

Command code	*Desig-nation*	*Description*	*Access limit*			*Note*
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0x80	(System reservation)					
0x81						
0x82	DCH12	Ch12 measured value	R	○	○	
0x83	DCH13	Ch13 measured value	R	○	○	
0x84	DCH14	Ch14 measured value	R	○	○	
0x85	DCH15	Ch15 measured value	R	○	○	
0x86 : 0x8D	(System reservation)					
0x8E	CREF12	Current Ch12 reference value	R	○	○	Result of drift compensation is reflected.
0x8F	CTHR12	Current Ch12 judging change	R	○	○	Result of drift compensation is reflected.
0x90	CHYS12	Current Ch12 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x91	CREF13	Current Ch13 reference value	R	○	○	Result of drift compensation is reflected.
0x92	CTHR13	Current Ch3 judging change	R	○	○	Result of drift compensation is reflected.
0x93	CHYS13	Current Ch13 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x94	CREF14	Current Ch14 reference value	R	○	○	Result of drift compensation is reflected.
0x95	CTHR14	Current Ch14 judging change	R	○	○	Result of drift compensation is reflected.
0x96	CHYS14	Current Ch14 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x97	CREF15	Current Ch15 reference value	R	○	○	Result of drift compensation is reflected.
0x98	CTHR15	Current Ch15 judging change	R	○	○	Result of drift compensation is reflected.
0x99	CHYS15	Current Ch15 hysteresis value	R	○	○	Result of drift compensation is reflected.
0x9A : 0xBA	(System reservation)					
0xBB	OUTSEL	Channel setting for OUT pins	R/W		○	
0xBC : 0xBF	(System reservation)					
0xC0	REF12	Ch12 reference value	R/W		○	
0xC1	THR12	Ch12 judging change	R/W		○	

Command code	*Desig-nation*	*Description*	*Access limit*			*Note*
			Read (R)/Write (W)	Normal measurement mode	Setup mode	
0xC2	HYS12	Ch12 hysteresis	R/W		○	
0xC3	RTHR12	Ch12 On-judgment ratio	R/W		○	
0xC4	RHYS12	Ch12 hysteresis ratio	R/W		○	
0xC5	REF13	Ch13 reference value	R/W		○	
0xC6	THR13	Ch13 judging change	R/W		○	
0xC7	HYS13	Ch13 hysteresis	R/W		○	
0xC8	RTHR13	Ch13 On-judgment ratio	R/W		○	
0xC9	RHYS13	Ch13 hysteresis ratio	R/W		○	
0xCA	REF14	Ch14 reference value	R/W		○	
0xCB	THR14	Ch14 judging change	R/W		○	
0xCC	HYS14	Ch14 hysteresis	R/W		○	
0xCD	RTHR14	Ch14 On-judgment ratio	R/W		○	
0xCE	RHYS14	Ch14 hysteresis ratio	R/W		○	
0xCF	REF15	Ch15 reference value	R/W		○	
0xD0	THR15	Ch15 judging change	R/W		○	
0xD1	HYS15	Ch15 hysteresis	R/W		○	
0xD2	RTHR15	Ch15 On-judgment ratio	R/W		○	
0xD3	RHYS15	Ch15 hysteresis ratio	R/W		○	
0xD4 : 0xFF	(System reservation)					

6.2 Description of commands

6.2.1 ID: Chip ID (read only)

Used as ID of the chip. The data is fixed to **0x0101**

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1

6.2.2 BDATA: Detection result of touch/no-touch for each channel (read only)

Measured value for each channel is indicated by 1/0.
1: Off (no-touch), 0: On (touch) ; however; this is indicated, as stated per the BPOL command, stated in 6.2.9

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x01	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

6.2.3 DCHx: Measured value for each channel (read only)

Measured value for each channel is indicated by an unsigned 16-bit integer.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x02..0x0D 0x82..0x85	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (DCH0)	Command code 0x02
Channel 1 (DCH1)	Command code 0x03
Channel 2 (DCH2)	Command code 0x04
Channel 3 (DCH3)	Command code 0x05
Channel 4 (DCH4)	Command code 0x06
Channel 5 (DCH5)	Command code 0x07
Channel 6 (DCH6)	Command code 0x08
Channel 7 (DCH7)	Command code 0x09
Channel 8 (DCH8)	Command code 0x0A
Channel 9 (DCH9)	Command code 0x0B
Channel 10 (DCH10)	Command code 0x0C
Channel 11 (DCH11)	Command code 0x0D
Channel 10 (DCH12)	Command code 0x82
Channel 11 (DCH13)	Command code 0x83
Channel 10 (DCH14)	Command code 0x84
Channel 11 (DCH15)	Command code 0x85

6.2.4 CREFx: Current reference value for each channel (read only)

Current reference value for each channel is indicated by an unsigned 16-bit integer.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0E..0x2F 0x8E..0x97	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (CREF0)	Command code 0x0E
Channel 1 (CREF1)	Command code 0x11
Channel 2 (CREF2)	Command code 0x14
Channel 3 (CREF3)	Command code 0x17
Channel 4 (CREF4)	Command code 0x1A
Channel 5 (CREF5)	Command code 0x1D
Channel 6 (CREF6)	Command code 0x20
Channel 7 (CREF7)	Command code 0x23
Channel 8 (CREF8)	Command code 0x26
Channel 9 (CREF9)	Command code 0x29
Channel 10 (CREF10)	Command code 0x2C
Channel 11 (CREF11)	Command code 0x2F
Channel 12 (CREF12)	Command code 0x8E
Channel 13 (CREF13)	Command code 0x91
Channel 14 (CREF14)	Command code 0x94
Channel 15 (CREF15)	Command code 0x97

6.2.5 CTHRx: Current variation for each channel judging change (read only)

Current variation for each channel judging change is indicated by an unsigned 16-bit integer.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0F..0x30 0xC1..0xD0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (CTHR0)	Command code 0x0F
Channel 1 (CTHR1)	Command code 0x12
Channel 2 (CTHR2)	Command code 0x15
Channel 3 (CTHR3)	Command code 0x18
Channel 4 (CTHR4)	Command code 0x1B
Channel 5 (CTHR5)	Command code 0x1E
Channel 6 (CTHR6)	Command code 0x21
Channel 7 (CTHR7)	Command code 0x24
Channel 8 (CTHR8)	Command code 0x27
Channel 9 (CTHR9)	Command code 0x2A
Channel 10 (CTHR10)	Command code 0x2D
Channel 11 (CTHR11)	Command code 0x30
Channel 12 (CTHR12)	Command code 0xC1
Channel 13 (CTHR13)	Command code 0xC6
Channel 14 (CTHR14)	Command code 0xCB
Channel 15 (CTHR15)	Command code 0xD0

6.2.6 CHYSx: Current hysteresis for each channel (read only)

Current hysteresis for each channel is indicated by an unsigned 16-bit integer.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x10..0x31 0x90..0x99	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (CHYS0)	Command code 0x10
Channel 1 (CHYS1)	Command code 0x13
Channel 2 (CHYS2)	Command code 0x16
Channel 3 (CHYS3)	Command code 0x19
Channel 4 (CHYS4)	Command code 0x1C
Channel 5 (CHYS5)	Command code 0x1F
Channel 6 (CHYS6)	Command code 0x22
Channel 7 (CHYS7)	Command code 0x25
Channel 8 (CHYS8)	Command code 0x28
Channel 9 (CHYS9)	Command code 0x2B
Channel 10 (CHYS10)	Command code 0x2E
Channel 11 (CHYS11)	Command code 0x31
Channel 12 (CHYS12)	Command code 0x90
Channel 13 (CHYS13)	Command code 0x93
Channel 14 (CHYS14)	Command code 0x96
Channel 15 (CHYS15)	Command code 0x99

6.2.7 MSA Teaching measurement count (read/write enabled only in setup mode)

When a sequence of MSA x 64 On is detected, the Off status is assumed and the drift compensation is forcibly executed. When MSA=0x00, this function is disabled (i.e., no forced drift compensation occurs). This function allows canceling continuous ON status caused by an object placed over the electrode.
Default = 0 (no forced drift compensation) 8-bit unsigned integer representation

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x36	1	1	1	1	1	1	1	1	D7	D6	D5	D4	D3	D2	D1	D0

6.2.8 DCI Teaching measurement count (read/write enabled only in setup mode)

Drift compensation per $2^{(DCI)}$ is not executed. 3-bit unsigned integer.
Default = 5 (drift compensation occurs once per 2^5=32 times.)

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x37	1	1	1	1	1	1	1	1	1	1	1	1	1	D2	D1	D0

6.2.9 BPOL: On/Off output polarity (read/write enabled only in setup mode)

Sets the output polarity logic for the OUT_A and OUT_B pins.
0: Active Low (OUTx pins go Low for On) (Default)
1: Active High (OUTx pins go High for On)
*BPOL setting has an effect on output logic at OUT_A and OUT_B terminal, set in OUTSEL.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x38	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

6.2.10 CHEN: Measurement enable for each channel (read/write enabled only in setup mode)

Enable / Disbale measurement per channel
1: measurement executed, 0: not executed

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x39	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

6.2.11 TOG: Toggle action (read/write enabled only in setup mode)

Selects momentary or latching output mode. This output takes effect on the signals output from OUT_A or Out_B and BDATA command data.
1: Toggle mode off (momentary action: turned on only during a touch event)
0: Toggle mode on (alternate action: turned on with the first touch event and off with the next touch event)

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x3B	CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

6.2.12 ACD: Judging count (read/write enabled only in setup mode)

Only after consecutive measurement ACD value + 1{one times, a touch (or no-touch) is judged and this output is varied. This takes effect on the output signals from OUT0 - 15 and BDATA command data.
For example, with ACD = 2, after three consecutive measurements are judged as a touch event (or no-touch event), the output state changes.
The lower 8 bits are used to set the cumulative judgment count for Off to On transition (ACDon) and the upper 8 bits are used to set the cumulative judgment count for On to Off transition (ACDoff).

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x3C	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

D7 - D0 : ACDon (Default: 0010b)
Sets the cumulative judgment count for touch Off to On transition.
D15 - D8 : ACDoff (Default: 0010b)
Sets the cumulative judgment count for touch On to Off transition.

The set cumulative judgment count values are applied to the results from all the channels.

6.2.13 SLP: Sleep time (read/write enabled only in setup mode)

Defines the duty cycle between one measurement and the next measurement (operate time and sleep time).
Sleep mode is activated for SLP value × 10mS (Typ)
When SLP is set to “0”, measurements are made consecutively without sleep time.
Only the lower-order 8 bits are valid. If the other bits are written to, they are ignored.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x3D	1	1	1	1	1	1	1	1	D7	D6	D5	D4	D3	D2	D1	D0

6.2.14 MODE: Operation mode (read/write enabled only in setup mode)

Select active mode.
Only the bits described are valid.
If the other bits are written to, they are ignored.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x3E	1	1	1	1	1	1	1	1	1	1	1	1	DCF	DC	CHG	1

DC: Drift compensation
Enable/disable the drift compensation function.
1: Drift compensation is enabled. 0: Drift compensation is disabled.

DCF: Drift compensation type
Sets the target for drift compensation.
0: Only the reference value is corrected. The On-judgment variation quantity and hysteresis are not corrected.
1: All values are corrected (default).

CHG: CHG pin function
Defines the signal from the CHG pin in the normal measurement mode.
1: when on/off changes in any channel (when any channel is touched (comes into on state) or changes from touch to no-touch (goes to off state), the signal is high.
0: the signal is high every time a measurement finishes.

6.2.15 ROMSTR: EEPROM write (only write is enabled in setup mode)

When this command is issued by setting the data to 0x5354, all the parameter data are written to the build in EEPROM.
(The command set 0xBF+0x00+0x53+0x54 is sent from the host.)
If the data is different than 0x5354, this command is ignored.
Until this command is issued, the written data is stored in RAM. The content stored in RAM is referred during operation.)
Data will be lost when the power is turned off.
During write to the EEPROM, the CHG pin remains low.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x3F	0	1	0	1	0	0	1	1	0	1	0	1	0	1	0	0

6.2.16 OUTSEL: Out pins output CH setting (read/write enabled only in setup mode)

Capacity measurement result at any Ch will be output from /OUT_A and /OUT_B pins.
Each /OUT pins is negative logic output at the default status. (possible to change positive logic at the command of BPOL)

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0xBB	1	1	1	1	1	1	1	1	OB3	OB2	OB1	OB0	OA3	OA2	OA1	OA0

OB3-OB0 : /OUT_B pin output CH setting(0-Fh) : default is CH1
OA3-OA0 : /OUT_A pin output CH setting(0-Fh) : default is CH0

6.2.17 REFx: Reference value for each channel (read/write enabled only in setup mode)

The reference value for each channel can be set with an unsigned 16-bit integer.
Can only be changed in setup mode or rewrite automatically by teaching.
It is not changed by drift compensation.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x40..0x77 0xC0..0xCF	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (REF0)	Command code 0x40
Channel 1 (REF1)	Command code 0x45
Channel 2 (REF2)	Command code 0x4A
Channel 3 (REF3)	Command code 0x4F
Channel 4 (REF4)	Command code 0x54
Channel 5 (REF5)	Command code 0x59
Channel 6 (REF6)	Command code 0x5E
Channel 7 (REF7)	Command code 0x63
Channel 8 (REF8)	Command code 0x68
Channel 9 (REF9)	Command code 0x6D
Channel 10 (REF10)	Command code 0x72
Channel 11 (REF11)	Command code 0x77
Channel 12 (REF12)	Command code 0xC0
Channel 13 (REF13)	Command code 0xC5
Channel 14 (REF14)	Command code 0xCA
Channel 15 (REF15)	Command code 0xCF

6.2.18 THRx: Defines the signal change or threshold to judge a touch event(read/write enabled only in setup mode)

signal change or Threshold to judge a touch event for each channel can be set with an unsigned 16-bit integer.
Can only be changed in setup mode or rewrite automatically by teaching.
It is not changed by drift compensation.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x41..0x78 0xC1..0xD0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (THR0)	Command code 0x41
Channel 1 (THR1)	Command code 0x46
Channel 2 (THR2)	Command code 0x4B
Channel 3 (THR3)	Command code 0x50
Channel 4 (THR4)	Command code 0x55
Channel 5 (THR5)	Command code 0x5A
Channel 6 (THR6)	Command code 0x5F
Channel 7 (THR7)	Command code 0x64
Channel 8 (THR8)	Command code 0x69
Channel 9 (THR9)	Command code 0x6E
Channel 10 (THR10)	Command code 0x73
Channel 11 (THR11)	Command code 0x78
Channel 12 (THR12)	Command code 0xC1
Channel 13 (THR13)	Command code 0xC6
Channel 14 (THR14)	Command code 0xCB
Channel 15 (THR15)	Command code 0xD0

6.2.19 HYSx: Hysteresis for each channel (read/write enabled only in setup mode)

Hysteresis for each channel can be set with an unsigned 16-bit integer.
Can only be changed in setup mode or rewrite automatically by teaching.
It is not changed by drift compensation.

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x42..0x79 0xC2..0xD1	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Channel 0 (HYS0)	Command code 0x42
Channel 1 (HYS1)	Command code 0x47
Channel 2 (HYS2)	Command code 0x4C
Channel 3 (HYS3)	Command code 0x51
Channel 4 (HYS4)	Command code 0x56
Channel 5 (HYS5)	Command code 0x5B
Channel 6 (HYS6)	Command code 0x60
Channel 7 (HYS7)	Command code 0x65
Channel 8 (HYS8)	Command code 0x6A
Channel 9 (HYS9)	Command code 0x6F
Channel 10 (HYS10)	Command code 0x74
Channel 11 (HYS11)	Command code 0x79
Channel 12 (HYS12)	Command code 0xC2
Channel 13 (HYS13)	Command code 0xC7
Channel 14 (HYS14)	Command code 0xCC
Channel 15 (HYS15)	Command code 0xD1

6.2.20 RTHRx: On-judgment ratio of each channel

Used in teaching.
Sets the ratio of the quantity of judging change (THRx) to the measured value observed in teaching with an unsigned 4-bit integer. (Refer to “7. Teaching” for details)
Only the lower-order 4 bits are valid. If the other bits are written to, they are ignored.
If the measured value changes by ΔA due to a touch during teaching, the quantity of judging change that is newly set in teaching (THRx) is calculated as:
Quantity of judging change (THRx) = ΔA × (on-judgment ratio (RTHRx)+1)/16

For example, if RTHRx = 10, the quantity of judging change (THRx) is:
THRx = ΔA × (10 + 1)/16 ≅ ΔA × 0.69 (about 70% of Δa)

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x43..0xD2	1	1	1	1	1	1	1	1	1	1	1	1	D3	D2	D1	D0

* Refer to "6.1 List of commands" for the command code corresponding to each channel.

6.2.21 RHYSx: Hysteresis ratio for each channel

Used in teaching.
Sets the ratio of hysteresis (HYSx) to the measured value observed in teaching with an unsigned 4-bit integer. (Refer to “7. Teaching” for details)
Only the lower-order 4 bits are valid. If the other bits are written to, they are ignored.
If the measured value changes only by ΔA due to a touch during teaching, the new hysteresis that is set in teaching (HYSx) is calculated as:
Hysteresis (HYSx) = ΔA × (Hysteresis ratio (RHYSx))/16

For example, if RHYSx = 2, hysteresis (HYSx) is:
HYSx = ΔA × 2/16 ≅ ΔA × 0.13 (about 13% of Δa)

Command code	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x44..0xD3	1	1	1	1	1	1	1	1	1	1	1	1	D3	D2	D1	D0

* Refer to "6.1 List of commands" for the command code corresponding to each channel.

7. Teaching

7.1 Outline of teaching

Such parameters as the quantity of judging change can be set automatically through actual touches on the electrode. This operation is called "Teaching".

When teaching, the reference value (REFx), quantity of judging change (THRx) and hysteresis (HYSx) are updated appropriately, and stored in the EEPROM built into the chip.

Teaching is executed with the B6T Development Tool Workbench.

7.2 Preparation for teaching

See the new B6T Workbench manual

7.3 Performing teaching

See the new B6T Workbench manual

7.4 Checking the result of teaching

See the new B6T Workbench manual

8. Electrical characteristics

8.1 Absolute maximum ratings

Desig-nation	Item	Condition	Rated value	Unit
V_{dd}	Supply voltage		-0.3 - 6.5	V
V_I	Input voltage		-0.3 - V_{dd} +0.3	V
V_O	Output voltage		-0.3 - V_{dd} +0.3	V
P_d	Power dissipation	T_{opr}=25°C	300	mW
T_{opr}	Ambient operating temperature		-40 - 85	°C
T_{stg}	Storage temperature		-65 - 150	°C

8.2 Recommended operating conditions

Note 1: *Unless otherwise specified, V_{dd} = 4.5 - 5.5V, T_{opr} = -20 - 85°C*

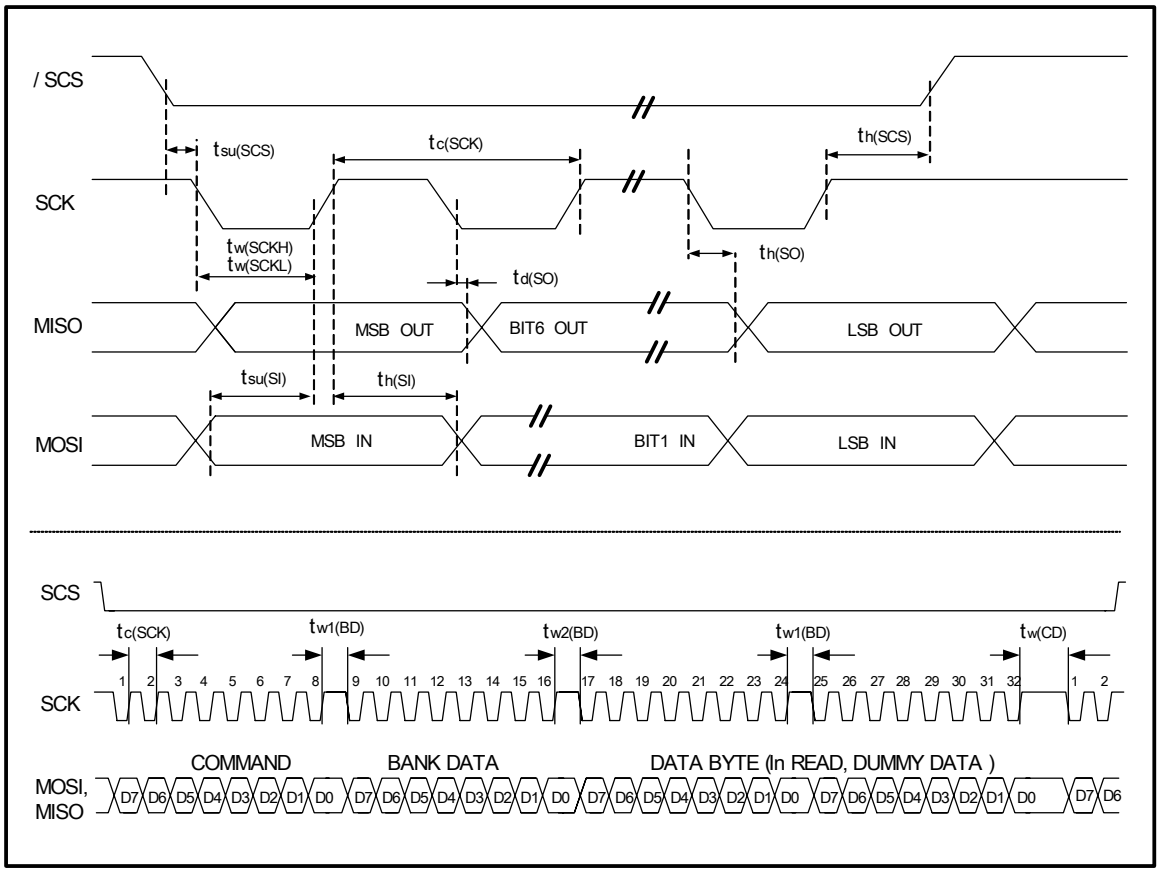
Desig-nation	Item	Condition	Rated value			Unit
			Minimum	Standard	Maximum	
V_{dd}	Supply voltage		3.0		5.5	V
V_{IH}	High input voltage		0.7V_{dd}		V_{dd}	V
V_{IL}	Low input voltage		0		0.3V_{dd}	V
I_{OH}	High output current				25	mA
I_{OL}	Low output current				-25	mA

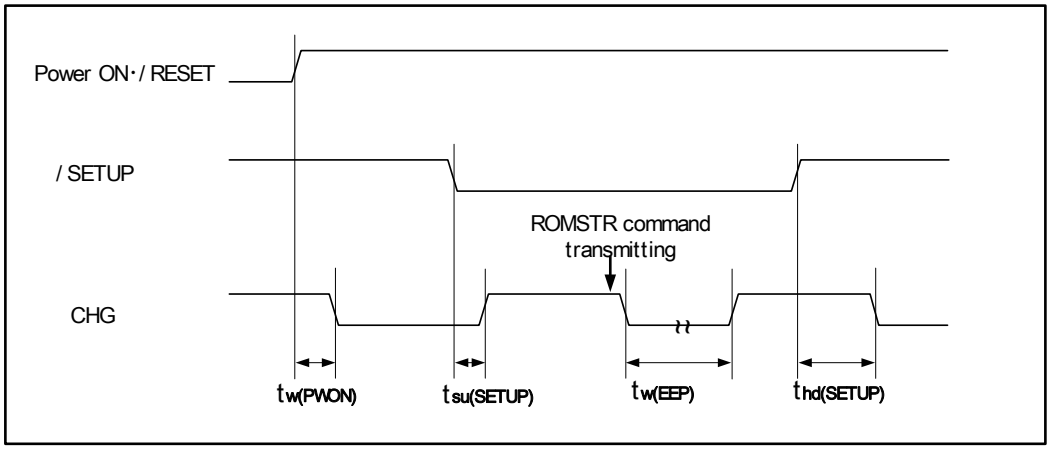
8.3 Electrical characteristics (*for reference only)

Desig-nation	Item	Condition	(Note 1)			Unit
			Minimum	Standard	Maximum	
V_{OH}	High Output voltage	I_{OH}=-5mA	V_{dd} –1.6		V_{dd}	V
V_{OL}	Low Output voltage	I_{OL}=5mA			1.3	V
I_{IH}	High Input current	V_I=5V			5	µA
I_{IL}	Low Input current	V_I=0V			-5	µA
I_{CC}	Supply current	Normal measurement mode		12		mA
-	Number of times of EEPROM write	T_{OPR}=0-60°C	300,000			Times
-	EEPROM write time	V_{dd}=5V,T_{OPR}=25°C (Note 2)		100	9000	mS
-	EEPROM data retention period	T_{OPR}=55°C	20			Years

Note 1: Unless otherwise specified, V_{dd} = 4.5 - 5.5V, T_{opr} = -20 - 85°C
Note 2: The period following receipt of the EEPROM write command in setup mode until the data write finishes.

8.4 Necessary Timing Conditions





Desig-nation	Item	Condition	Rated value			Unit
			Minimum	Standard	Maximum	
$t_{c(SCK)}$	Serial communication clock cycle time		16			µS
$t_{w(SCKH)}$	Serial communication clock high pulse width		8			µS
$t_{w(SCKL)}$	Serial communication clock low pulse width		8			µS
$t_{su(SETUP)}$	/SCS setup time to CLK		120			nS
$t_{w(SCKH)}$	/SCS hold time to CLK		120			nS
$t_{d(SO)}$	Serial communication output delay time		120			nS
$t_{h(SO)}$	Serial communication output hold time		0			nS
$t_{su(SI)}$	Serial communication input setup time		120			nS
$t_{h(SI)}$	Serial communication input hold time		120			nS
$t_{w1(BD)}$	Serial communication byte to byte interval1		15			µS
$t_{w2(BD)}$	Serial communication byte to byte interval2		50			µS
$t_{w(CD)}$	Serial communication command reception interval			400		µS
$t_{w(CHG)}$	CHG pulse width	(Note 2)		28		mS
$t_{w(PWON)}$	Measurement start delay time				100	mS
$t_{su(SETUP)}$	Mode shift delay time (Setup)	(Note 3)		120	200	µS
$t_{hd(SETUP)}$	Mode shift delay time (Hold)	(Note 4)			50	mS
$t_{w(RESET)}$	Reset pulse width		20			µS

Note 1 Unless otherwise specified, V_{dd} = 5.0V, T_{opr} = 25°C.

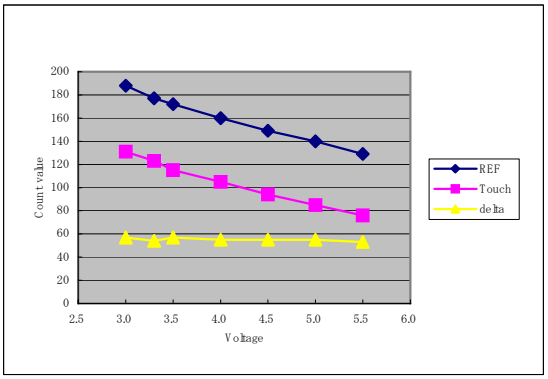
Note 2 This is the time period when the condition that CHG pulse width is at its minimum in the serial communication mode of normal measurement mode is set. (CHG pin function is set to output at the end of every measurement [CHG bit = 0 with MODE command]) and the sleep time is set to zero [SLP command value = 0]).

Note 3 The delay time for the mode shift from normal measurement mode to setup mode.
*This time is possible to vary in case of inserting large capacitor between /SETUP terminal and GND.

Note4 The delay time for the mode shift from setup mode to normal measurement mode.
*This time is possible to vary in case of inserting large capacitor between /SETUP terminal and GND.

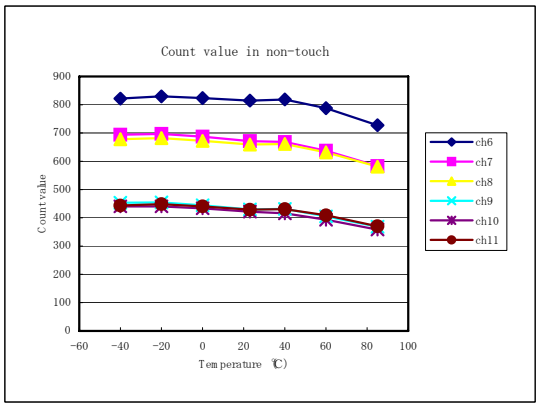
8.5 Measurement characteristics (typical example)

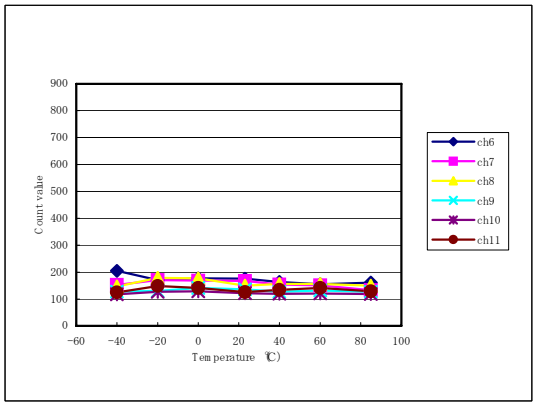
8.5.1 Power supply characteristic



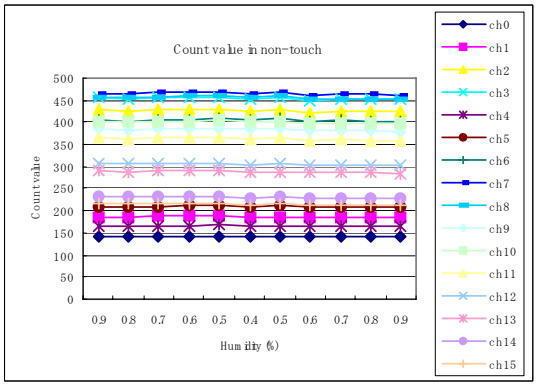
* Only Ch0 count value is described as representative one.

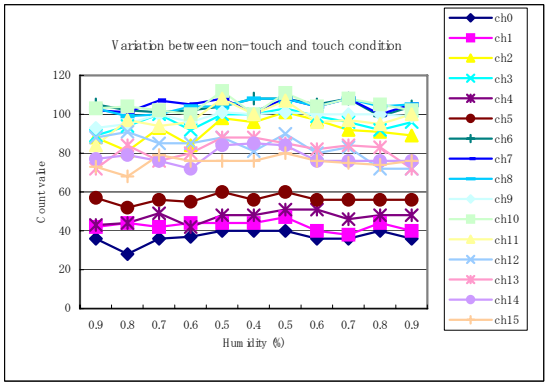
8.5.2 Temperature characteristic



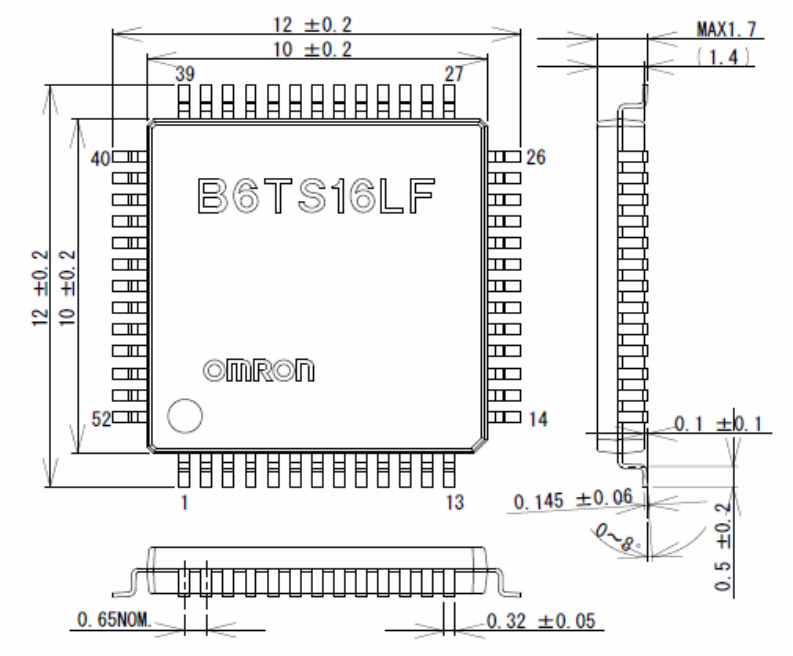


8.5.3 Humidity characteristic





9. Appearance and dimensions



Warranty Details

1. Warranty period
   The warranty period for an OMRON product is one year from purchase or delivery to a customer-specified place.

2. Scope of warranty
   If any OMRON product fails under OMRON liability within the above warranty period, OMRON shall supply a replacement or repair the product free of charge at the place of purchase. However, if the reason for the product failure falls into any of the following categories, the warranty will not apply:
   a) The product has been used or handled under conditions or in an environment not listed in the product's specifications, catalog, or operation manual (hereinafter referred to as the "catalog and the like").
   b) The failure has been caused by a non-OMRON product.
   c) The product has been modified or repaired by somebody or corporation other than OMRON.
   d) The product has been used for other than its intended use.
   e) The failure could not have been predicted based on the level of science or technology at the time of shipment.
   f) The failure has been caused by a natural or other disaster, an accident or the like that is not OMRON's liability.
   This warranty applies only to the OMRON product itself, and any damage induced by a failed OMRON product is excluded from this warranty.

3. Scope of service
   The price of an OMRON product does not include service expenses such as the cost of sending out technicians.
   If you wish to request non-inclusive services, please consult OMRON sales personnel.

4. Scope of application
   The above apply only to business and usage in Japan.
   Please consult OMRON sales personnel about business and usage in other countries.